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Nitrogen separation from domestic wastewater by reverse osmosis

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Abstract

Norway is committed by the North Sea Convention to reduce nitrogen in liquid effluents in general by 50% by 1995. The base year is 1985. Communities treating more than 10 000 p.e. are ordered to remove a minimum of 70% total nitrogen from domestic effluents in specified sensitive areas.

The Norwegian Environmental Protection Agency has completed a three-year study on alternative nitrogen removal processes suitable for Norwegian conditions. Existing secondary-treatment plants are by and large based on chemical precipitation which therefore could be considered pretreatment for future nitrogen removal plants.

Nitrogen separation trials by reverse osmosis (RO) was performed between October 1990 and August 1991 on domestic wastewater as well as on combined domestic–industrial wastewater. Separate RO trials were performed with both tubular and spiral-wound membrane elements. For domestic wastewater the separation efficiency was 95% for total nitrogen.

No pretreatment was necessary for tubular RO membranes in addition to the existing chemical precipitation performed in the main treatment plant. Chemical precipitated effluent from the main treatment plant was the feed to the RO units.

The spiral RO elements, however, did receive additional 25–200 μm cartridge filters as pretreatment. This was essential as solid separation in the chemical precipitation pretreatment plant was unpredictable, and carry-over solids easily clogged the spiral-wound flow channels. This was especially a problem for treatment of combined domestic–industrial wastewater and not during treatment of domestic wastewater only.

Chemical cleaning of the spiral-wound membranes was performed every other day for treatment of domestic wastewater. This ensured a permeate flux of 20 $l/m^2/h$ at 25°C and an inlet feedwater pressure of 35 kg/cm^2. No optimization of recovery rate was attempted during the trials. A full-scale design, however, for treating 40 and 200 m^3/h is included in the paper. Also, steam stripping of NH_3 from the retentate is suggested, with nitrogen recovered as $(NH_4)_2SO_4$, NH_4NO_3 or $(NH_4)_3PO_4$.

Keywords: Reverse osmosis; Nitrogen removal; Wastewater treatment; Fouling

1. Introduction

In the chemical industry, including wastewater treatment, separation processes are as important as chemical and biochemical reactions. It is not uncommon to find more than one third of the processing costs attributed to solids–water separation. Synthetic membranes can achieve separations in a wide variety of industrial processes, often with substantial energy savings over more traditional separation techniques. The membrane efficiency is critically dependent on permeability and selectivity. The membrane manufacturer does have the potential to tailor membranes to specific processing needs.

Currently, practical industrial membrane applications vary from small-scale batch separations in biotechnology and the pharmaceutical industries to very

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